
TEXAS TECH UNIVERSITY
Natural Science Research Laboratory

Occasional Papers

Museum of Texas Tech University Number 332 9 July 2015

Distribution and Natural History of Nelson's Pocket Mouse (*Chaetodipus nelsoni*) in the Guadalupe Mountains in Southeastern New Mexico

Kenneth N. Geluso and Keith Geluso

Abstract

The northern distributional limit of Nelson's Pocket Mouse (*Chaetodipus nelsoni*) in North America occurs in the Guadalupe Mountains of southeastern New Mexico, where the species previously was known only from two localized areas in Carlsbad Caverns National Park. The first records were from the early 1950s near the large opening to Carlsbad Cavern, close to the upper edge of the eastern escarpment of the mountain range, and more recent records (1973–2003) were reported from a 2.9-km stretch of escarpment ca. 13.5–16.4 km southwest of the cavern. In 2013, we conducted a survey for *C. nelsoni* along the face of the eastern escarpment in New Mexico. Herein, we report on eight new localities of occurrence and summarize the natural history of *C. nelsoni* at its northernmost limit. Our modest range extensions north and south of former records demonstrate a distribution spanning 48.5 km along the escarpment. New localities of occurrence likely represent previously undocumented areas where the species has always occurred in the mountain range. In the Guadalupe Mountains, Nelson's Pocket Mice occurred at elevations of 1,055–1,500 m on south-facing and southeast-facing slopes, with inclines of 18.5–29.0° (33.5–55.4%). Slopes contained characteristic vegetation of the Chihuahuan Desert and abundant amounts of exposed rock. At this northern part of its distribution, *C. nelsoni* was active throughout the year and on nights of new and full moons. Reproductive information in the Guadalupe Mountains still is limited for both males (scrotal testes March–August) and females (lactation in May). On slopes of the escarpment, *C. nelsoni* was most often associated with Lacey's White-ankled Deermouse (*Peromyscus laceianus*). The population of *C. nelsoni* in the Guadalupe Mountains appears geographically isolated from more southerly populations in Texas. Nelson's Pocket Mice have inhabited these mountains for at least 60 years (1952–2013), and at one location for at least 40 years (1973–2013). As of 2013, the population of *C. nelsoni* in the Guadalupe Mountains appeared stable.

Key words: *Chaetodipus nelsoni*, distribution, Guadalupe Mountains, natural history, Nelson's Pocket Mouse, New Mexico

INTRODUCTION

The northern distributional limit of Nelson's Pocket Mouse (*Chaetodipus nelsoni*) in North America occurs in the Guadalupe Mountains of southeastern New Mexico (Hall 1981), and Carlsbad Caverns National Park in Eddy County is the only place in the mountain range where this species is known to occur (Findley et al. 1975; Genoways et al. 1979; Geluso and Geluso 2004). The population in the Guadalupe Mountains appears geographically isolated from more southerly populations in the Trans-Pecos region of western Texas, with the closest known population ca. 112 km south-southwest in the Beach Mountains, Culberson County, Texas (Stangl et al. 1993). The geographic distribution of this pocket mouse continues southward through Texas into north-central Mexico (Hall 1981). Throughout most of its range, *C. nelsoni* inhabits rocky slopes with desert scrub vegetation in mountainous areas (Best 1994; Geluso and Geluso 2004).

The first reported capture of *C. nelsoni* in the Guadalupe Mountains occurred in Carlsbad Caverns National Park in 1953 (Webb 1954), but an unreported specimen in the park's museum was collected earlier in 1952 (Geluso and Geluso 2004). Both specimens were captured near the large natural opening to Carlsbad Cavern, close to the upper edge of the eastern escarpment of the mountain range. Four individuals were collected in the park in 1991 (Geluso and Geluso 2004), and recently we discovered another unreported specimen that was collected in the park in 1973. All five specimens were captured on slopes of the eastern escarpment near the mouth of Slaughter Canyon. In 2001, biologists from the National Park Service examined the status of the population and captured three individuals of *C. nelsoni* on the eastern escarpment between Yucca and Slaughter canyons, spanning a distance of 2.9 km (G. J. Emmons, pers. comm.). Lastly, in a study of the systematics and biogeography of *C. nelsoni*, D. J. Hafner (pers. comm.) obtained tissue samples from five more individuals in 2003, also from the escarpment between Yucca and Slaughter canyons.

Although surveys of mammals have been conducted throughout the Guadalupe Mountains of New Mexico and Texas since the early 1900s (Bailey 1905, 1928; Davis 1940; Davis and Robertson 1944; Genoways et al. 1979; Geluso 2004; Geluso and Geluso 2004), all records of occurrence for *C. nelsoni* were from two localized areas in Carlsbad Caverns National Park, New Mexico. In the early 1990s, Geluso and Geluso (2004) conducted surveys of rodents in the park by placing traps in every habitat, including those (1) in lowlands along the base of the Guadalupe Mountains (i.e., in desert scrubland, arid grassland, the juniper plain, alluvial fans, arroyos, wide draws, and riparian woodlots), (2) on the face of the eastern escarpment of the mountain range, and (3) in interior parts of the mountains (i.e., summits at different elevations, canyon floors, and canyonsides with slopes of different exposures, inclines, and elevations). Their survey resulted in the capture of >700 rodents, but *C. nelsoni* was captured only at a single site on a southeast-facing slope along the face of the escarpment. To determine whether the distribution of *C. nelsoni* was more widespread in the Guadalupe Mountains, we conducted a systematic search for this pocket mouse on slopes of the eastern escarpment in 2013. Herein, we report on all records of *C. nelsoni* from the Guadalupe Mountains and summarize what is presently known about its natural history in the mountain range. We also compare the natural history of the northern population of *C. nelsoni* in New Mexico to more southerly populations in the Trans-Pecos region of Texas.

MATERIALS AND METHODS

Study area.—This study was conducted in the Guadalupe Mountains, Eddy County, New Mexico. The Guadalupe Mountains are remains of a fossil reef that formed along an inland sea millions of years ago and are composed largely of limestone and dolomite (Hill 1987; Jagnow and Jagnow 1992). The relatively flat landscape that lies along the southeastern base of the mountains was once part of a vast seabed. Today, a long and curved escarpment stands above the surrounding plains, and its bottom edge marks the junction between the fossil reef and old seabed (Fig. 1). The escarpment is known as the Capitan reef escarpment

Figure 1. The Guadalupe Mountains of New Mexico and Texas stand above the surrounding plains. Where the flat landscape on the left side of the aerial photograph meets the base of the mountains represents the bottom edge of the eastern escarpment of the mountain range. The arrow points to the Visitor Center in Carlsbad Caverns National Park, New Mexico. El Capitan and Guadalupe Peak in Guadalupe Mountains National Park, Texas, can be seen in the extreme upper left-hand corner of the photograph. El Capitan (first prominent bump on left) is the southernmost bluff of the mountain range, and Guadalupe Peak (bump to the right of El Capitan) is the highest peak in Texas (photograph by Jeep Harding).

(Hill 1987), Guadalupe escarpment (Rice-Snow and Goodbar 2012), or simply the eastern escarpment of the Guadalupe Mountains.

The eastern escarpment of the Guadalupe Mountains is about 85 km in length from its northern end in New Mexico (8 km SW of the center of the city of Carlsbad, Fig. 2) to its southern tip in Texas (near El Capitan). In New Mexico, the escarpment's length is ca. 68 km. From north to south, the upper edge of the escarpment increases in elevation, and concurrently, the land along the escarpment's base (i.e., the seabed) also increases, but at a slower rate. Thus, the escarpment's face becomes taller from north to south. For example, at its northern end, the escarpment only stands about 90 m tall (the elevation at the base and upper edge of the escarpment is 1,000 and 1,090 m, respectively), but at the Texas-New Mexico border, the escarpment stands about 340 m above the lowlands (elevations of 1,560 and 1,900 m, respectively).

At intervals along the escarpment, numerous gullies and ravines cut into its face, resulting in areas of exposed slope separated by gullies and ravines. Thus, the escarpment's face has a segmented appearance of adjacent, longitudinal bulges (Fig. 3). The substrate of the escarpment consists of fine-grained, powdery soils covered by abundant amounts of exposed rock, including stones and cobbles of various sizes and shapes, boulders, and large slabs (Fig. 4). In addition to gullies

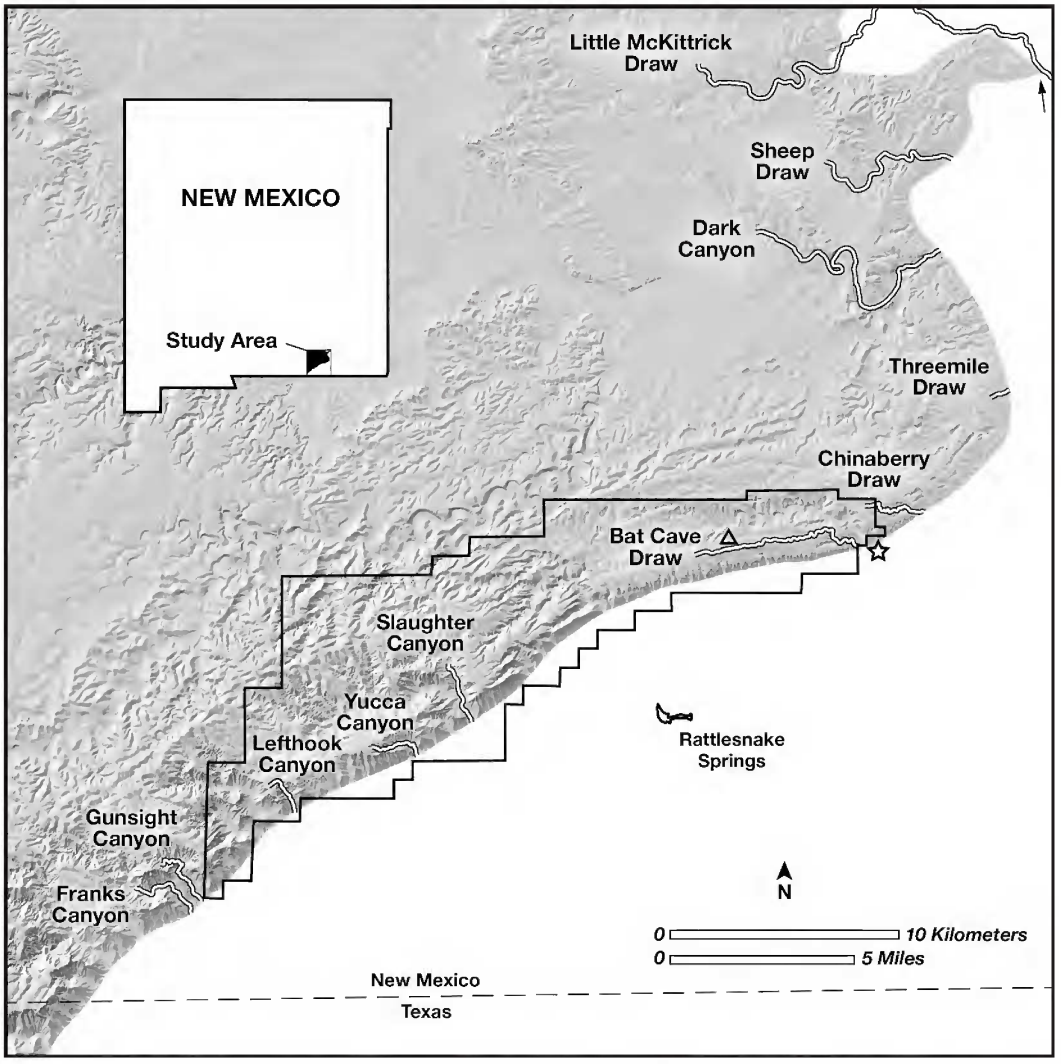

Figure 2. Map showing part of the Guadalupe Mountains in Eddy County, New Mexico, and a small part of the mountain range in Culberson County, Texas (extreme lower left-hand corner). The shaded area represents the mountains, and the white area represents the relatively flat land along the base of the mountains. Where the shaded area meets the white area represents the bottom edge of the eastern escarpment of the mountain range. The arrow points to the northern end of the escarpment near the city of Carlsbad. Many canyons and draws penetrate deep into the mountains' interior; only those mentioned in the text are shown in part or full. The boundary of Carlsbad Caverns National Park is shown by a black line, including Rattlesnake Springs. The triangle shows the location of the large natural opening to Carlsbad Cavern, and the star shows the location of Whites City. Map based on the topographic map of the United States Geological Survey (Carlsbad Quadrangle, New Mexico-Texas, 1:100 000-scale series, 1979).

Figure 3. Face of the eastern escarpment of the Guadalupe Mountains, showing exposed slopes separated by gullies and ravines. The mouth of Yucca Canyon in Carlsbad Caverns National Park, New Mexico, is shown on the far right (photograph taken by KNG in April 2013).

Figure 4. Stones, cobbles, boulders, and slabs of rock cover much of the ground on slopes of the eastern escarpment of the Guadalupe Mountains. Plants growing among the rocks in this view include Lechuguilla (*Agave lechuguilla*), Smooth Sotol (*Dasylirion leiophyllum*), prickly pear (*Opuntia*), and cloakfern (*Astrolepis*). This photograph was taken by KNG near the mouth of Slaughter Canyon in Carlsbad Caverns National Park, New Mexico, where a male Nelson's Pocket Mouse (*Chaetodipus nelsoni*) was captured and released on 12 and 13 March 2013. El Capitan and Guadalupe Peak in Guadalupe Mountains National Park, Texas, can be seen in the far distance (top center of photograph).

and ravines, mouths of canyons and draws occur along the face of the escarpment (Fig. 2).

In New Mexico, rocky slopes of the eastern escarpment face south and southeast (81% of total length), east (8%), and northeast (11%), and floristic differences were minimal along its entire length from our northernmost trapping sites (north of Sheep Draw) to our southernmost sites (near mouths of Gunsight and Franks canyons, Fig. 2). Common plants on exposed portions of slopes included prickly pear (*Opuntia*), Ocotillo (*Fouquieria splendens*), Lechuguilla (*Agave lechuguilla*), Smooth Sotol (*Dasylirion leiophyllum*), catclaw (*Acacia greggii*, *A. roemeriana*, or *Mimosa biuncifera* or some combination), Skeletonleaf Goldeneye (*Viguiera stenoloba*), spiny cactus (*Echinocereus*), cloakfern (*Astrolepis*), Mariola (*Parthenium incanum*), dalea (*Dalea*), Viscid Acacia (*Acacia neovernicosa*), Agarito (*Berberis trifoliolata*), and juniper (*Juniperus*). Less common plants on exposed portions of slopes included cholla (*Opuntia*), Spanish Dagger (*Yucca treculeana*), Mormon Tea (*Ephedra torreyana*), Mescalbean (*Sophora secundiflora*), Javelinabush (*Condalia ericoides*), oak (*Quercus*), Evergreen Sumac (*Rhus virens* subsp. *virens*), Littleleaf Sumac (*Rhus microphylla*), Oreganillo (*Aloysia wrightii*), Allthorn (*Koeberlinia spinosa*), and Desert Myrtlecroton (*Bernardia obovata*). Creosotebush (*Larrea tridentata*) was observed on lower portions of slopes in the mouth of Dark Canyon and near the mouth of Chinaberry Draw, and a Honey Mesquite (*Prosopis glandulosa*) was observed in the mouth of Sheep Draw.

Grasses were sparse (≤10% of ground cover) along traplines, except in some areas below Bat Cave Draw, where grasses accounted for up to 70% of cover in lower areas of slopes. Common species of grasses along the escarpment included Mesa Muhly (*Muhlenbergia tenuifolia*), Rough Tridens (*Tridens muticus* var. *elongatus*), Sideoats Grama (*Bouteloua curtipendula*), Tanglehead (*Heteropogon contortus*), and threeawn (*Aristida*). Most scientific and common names of plants follow Powell (1988, 1994).

Climate of the region is characterized by limited amounts of precipitation, hot summers, and mild winters. For example, Carlsbad Caverns National Park averages 417 mm of precipitation a year, with June (mean maximum surface temperature = 32.2° C), July (32.2° C), and August (31.1° C) representing the warmest months and December (mean minimum = 1.1° C) and January (0.6° C) representing the coldest months (Geluso and Geluso 2004).

Collection of data.—In 2013, we systematically trapped for Nelson's Pocket Mouse along the eastern escarpment 11–16 March, 7–12 April, 5–9 May, and 6–13 June on dates near the new moon. Sherman livetraps (7.6 by 8.9 by 22.9 cm, H. B. Sherman Traps, Tallahassee, Florida) were placed on exposed parts of slopes with traps spaced ca. 9 m apart and baited with birdseed and rolled oats. Traplines generally consisted of 40 traps, although shorter and longer lines occasionally were employed. Traplines began near bottom edges of slopes and continued up inclines. Traps were left at sites for one to three consecutive nights. Traps were set at 18 different areas along the escarpment's face; 400 traps were set for a single night, 380 traps were set for two consecutive nights, and 280 traps were set for three consecutive nights. A total of 2,000 trap nights were amassed, with a trap night defined as one trap set for a single overnight period.

Surrounding vegetation, substrate, and topography were recorded for each trapline, and at the beginning and end of each trapline, we recorded latitude and longitude with a handheld Global Positioning System (GPS 72, Garmin International, Olathe, Kansas), using North American Datum 1983 (NAD 83). Elevations of trapsites were determined from coordinates via Google Earth (accessed on 12 November 2013). Our lowest trapsite was 1,045 m and our highest 1,595 m. Incline of slopes was determined with an optical reading clinometer (PM-5, Suunto Precision Instruments, Espoo, Finland). Sightings for inclines were obtained from lower edges of slopes to the level of top trapsites. Inclines were recorded in degrees and as a percentage, where 45° equals a 100% incline. Slopes with traplines ranged from 6.0-30.0° (10.5-57.7%) and faced south or southeast, except for the slope in the mouth of Franks Canyon that faced southwest. In areas where slopes of the escarpment faced northeast or east, traps were set on southeast-facing and south-facing slopes by placing traps where the escarpment curved inward and entered mouths of canyons or draws (e.g., in the mouth of Dark Canyon, Fig. 2); such slopes were considered as part of the escarpment.

Sex, age, reproductive condition, and body weight were recorded for each *C. nelsoni* captured, and color photographs were taken of each individual (e.g., Fig. 5, reproduced here in grayscale). At capture sites, latitude and longitude were recorded, as well as dominant plant species and types of rock within 4.6 m of the trap. Each capture site was documented with color photographs. For traps left at sites more than one night, Nelson's Pocket Mice captured the first night were marked with a semipermanent ink spot on tails to recognize recaptures. Only sex, age, and reproductive condition were recorded for other species of mammals captured in traps.

All animals captured in Carlsbad Caverns National Park were released at capture sites, but several individuals captured outside the park were kept as voucher specimens and deposited in the Museum of Southwestern Biology, University of New Mexico, Albuquerque (MSB). Information from other specimens of *C. nelsoni* captured in the Guadalupe Mountains also was gathered, including specimens housed in natural history collections at Carlsbad Caverns National Park (CACA); the New Mexico Museum of Natural History, Albuquerque (NMMNH); and University of Kansas Museum of Natural History, Lawrence (KU; also see the species account of *C. nelsoni* in Geluso and Geluso 2004). In addition, unpublished information about *C. nelsoni* was incorporated from captures by G. J. Emmons (pers. comm.) in 2001 and D. J. Hafner (pers. comm.) in 2003 at Carlsbad Caverns National Park. Information on a specimen collected in the park in 1973 also was included; the specimen formerly was housed at the University of Illinois Museum of Natural History, Urbana (UIMNH 47270) but is presently at MSB (184756). Institutional abbreviations follow Hafner et al. (1997).

Figure 5. This male Nelson's Pocket Mouse (*Chaetodipus nelsoni*) was captured and released in the mouth of Sheep Draw, Guadalupe Mountains, New Mexico on 8 June 2013. Note the numerous and well-developed rump spines.

RESULTS AND DISCUSSION

During our survey in 2013, 18 individuals of *C. nelsoni* were captured in the Guadalupe Mountains in southeastern New Mexico. All previous records (n = 15) of this species in the mountain range also are from New Mexico, including two in the 1950s, one in 1973, four in 1991, three in 2001, and five in 2003. No record of *C. nelsoni* is known from the southern tip of the Guadalupe Mountains in Culberson and Hudspeth counties, Texas (Genoways et al. 1979). Specific locality descriptions for the 33 records are given in the Appendix.

Distribution.—Nelson's Pocket Mice were documented from eight new areas along the face of the eastern escarpment of the Guadalupe Mountains (Fig. 6). The length of escarpment encompassing those areas extends 48.5 km and includes sites both north and south of prior localities of occurrence. Our northernmost capture in the mouth of Sheep Draw represents a modest range extension of 18.3 km north-northeast of the former northern record near Carlsbad Cavern, and it also represents the northernmost record of *C. nelsoni* in North America. We were unsuccessful in capturing *C. nelsoni* north of Sheep Draw at two localities (Fig. 6). Our southernmost capture near the mouth of Lefthook Canyon represents a minor extension of 5.1 km west-southwest of the previous southern record near the mouth of Yucca Canyon, and it also represents the southernmost record of *C. nelsoni* in the Guadalupe Mountains. We were unsuccessful in capturing *C. nelsoni* farther south near mouths of Gunsight and Franks canyons in New Mexico (Fig. 6).

New distributional records of *C. nelsoni* reported herein represent range extensions and not expansions in distribution for the species (sensu, Frey 2009). New records likely reflect inadequate past sampling of optimal habitat in the Guadalupe Mountains; that is, slopes of the eastern escarpment. For example, excluding traps where Geluso and Geluso (2004) captured *C. nelsoni* on the escarpment during surveys of rodents in Carlsbad Caverns National Park, only 333 additional traps were set in other areas along the escarpment. At some sites, success in capturing *C. nelsoni* increased when traps remained for more than a single night. For example, 44% (8 of 18) of our captures of *C. nelsoni* in 2013 occurred only on second or third nights of trapping (Table 1). Of the 333 traps mentioned above, most (85%) were set for a single night.

Habitat.—Nelson's Pocket Mice were captured at elevations of 1,055–1,500 m on south-facing and southeast-facing slopes of the eastern escarpment (Table 1). Slopes had inclines of 18.5–29.0° (33.5–55.4%) and contained abundant amounts of exposed rock consisting of combinations of stones, cobbles, boulders, and large slabs (Fig. 4). The substrate consisted of fine-grained, powdery soils. Common plants near capture sites included prickly pears (occurred at 100% of sites), cloakferns (100%), Ocotillo (94%), spiny cactuses (72%), Lechuguilla (67%), catclaws (61%), Skeletonleaf Goldeneye (61%), Smooth Sotol (56%), Mariola (44%), daleas (44%), Mormon Tea (28%), Viscid Acacia (22%), Spanish Dagger (17%), and junipers (17%). Plants occurring at <10% of capture sites included chollas, Mescalbean, Javelinabush, and Agarito. Grasses around trapsites were sparse (≤10% cover), except at one site where grasses covered ca. 30% of the ground (locality 7, Fig. 6).

Given our protocol, *C. nelsoni* was captured only on exposed parts of slopes between gullies and ravines (Fig. 3). For the same reason, D. J. Hafner (pers. comm.) only captured them (n = 5) on exposed parts of slopes in 2003. However, in 2001, G. J. Emmons (pers. comm.) captured three individuals in rocky gullies that cut into the face of the escarpment. Captures by Hafner and Emmons occurred at elevations of 1,300–1,425 m on south-facing and southeast-facing slopes near mouths of Slaughter and Yucca canyons (Fig. 6 and Appendix). Slopes contained abundant amounts of rock and had inclines ≥20° (≥36.4%).

Captures of *C. nelsoni* near the large natural opening to Carlsbad Cavern in the early 1950s occurred close to the upper edge of the eastern escarpment (Fig. 6). In the early 1990s, Geluso and Geluso (2004) failed to detect *C. nelsoni* in rocky habitats near those two early capture sites. Their traplines were placed along Bat Cave Draw and on summits dominated by scattered Red Berry Juniper (*Juniperus pinchotii*). Other common plants on those summits included prickly pears,

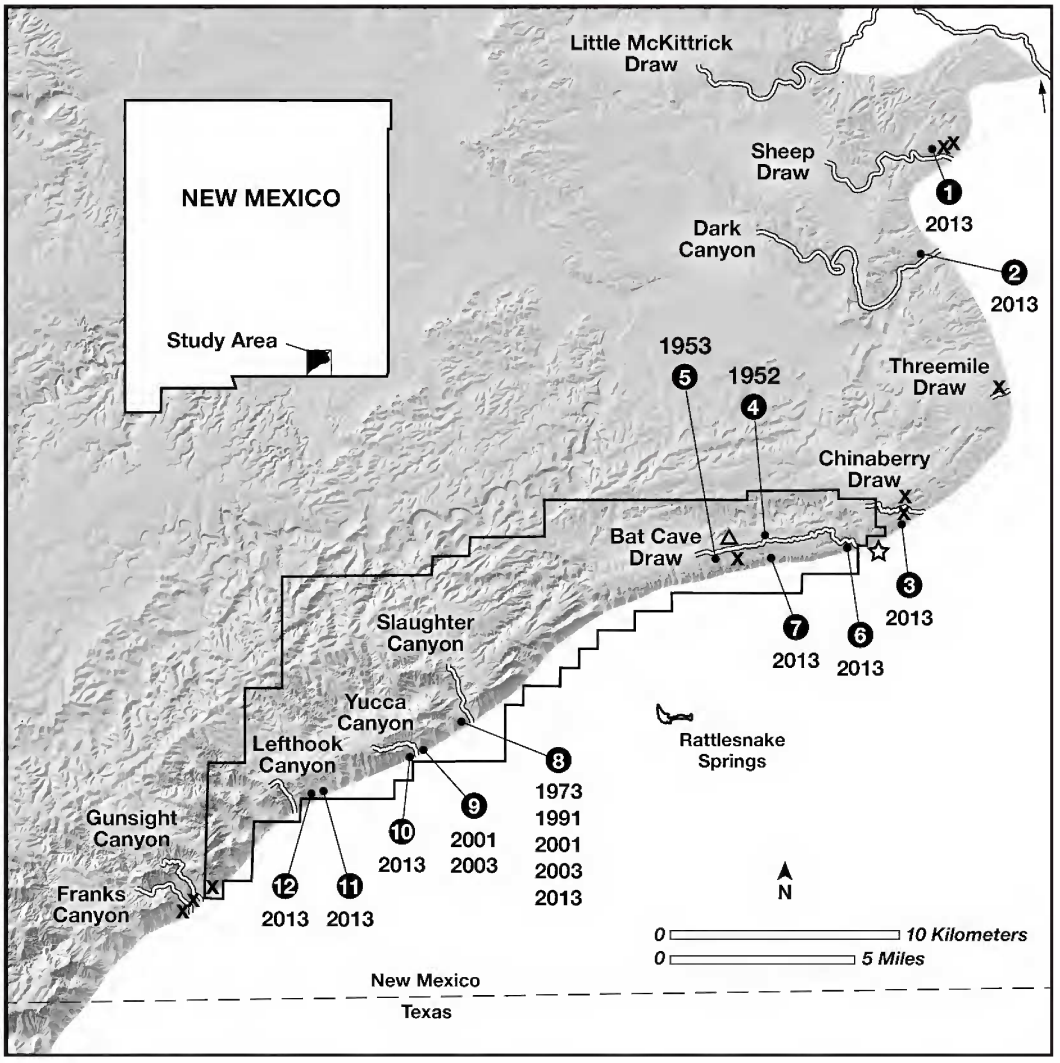

Figure 6. Distribution of Nelson's Pocket Mouse (*Chaetodipus nelsoni*) in the Guadalupe Mountains in southeastern New Mexico. No record of this species is known from the part of the mountain range in Texas. Small black dots represent localities of all known records for *C. nelsoni* in New Mexico. Each dot is identified by a number that corresponds to numbers in the Appendix. The year or years that individuals were captured at each locality are shown next to numbered circles. X symbols represent localities where *C. nelsoni* was not captured in 2013. The shaded area represents the mountains, and the white area represents relatively flat land along the base of the mountains. The boundary of Carlsbad Caverns National Park is shown by a black line, including Rattlesnake Springs. The triangle, star, and arrow are explained in the legend to Fig. 2.

catclaws, Smooth Sotol, Lechuguilla, Ocotillo, and Skeletonleaf Goldeneye; and the substrate contained stones, cobbles, slabs of rock, and tiers of low, rocky ledges.

In 2013, *C. nelsoni* was not captured on slopes of the escarpment with gradual inclines near the mouth of Sheep Draw (inclines 6, 7, and 10.5° or 10.5, 12.3, and 18.3%) or in the mouth of Threemile Draw (10° or 17.6%, Fig. 6). Traps were set multiple nights at both sites (total trap nights = 240 and 160, respectively) on rocky slopes similar in exposure, elevation (1,045–1,100 m), and types of vegetation to other slopes occupied by *C. nelsoni*. In fact, four *C. nelsoni* were

Table 1. Elevations of capture sites for 18 Nelson's Pocket Mice (*Chaetodipus nelsoni*) from slopes of the eastern escarpment of the Guadalupe Mountains in southeastern New Mexico in 2013. Slopes faced south or southeast and are further described by their incline in degrees and as a percentage. Localities of occurrence are listed from north to south (Fig. 6), and GPS coordinates are given in the Appendix. Sex, date of capture, and night of capture (i.e., captured on first, second, or third night of trapping) for each individual also are presented.

Sex	Date of capture	Locality	Elevation (m)	Incline ° (%)
male[1]	7 June	in mouth of Sheep Draw	1,090	18.5 (33.5)
male[2]	8 June	in mouth of Sheep Draw	1,090	22.5 (41.4)
female[1]	7 June	in mouth of Sheep Draw	1,055	18.5 (33.5)
male[2]	8 June	in mouth of Sheep Draw	1,060	22.5 (41.4)
male[1]	6 May	in mouth of Dark Canyon	1,055	29.0 (55.4)
male[1]	6 May	in mouth of Dark Canyon	1,095	27.0 (51.0)
male[1]	8 April	near mouth of Chinaberry Draw	1,115	19.0 (34.4)
male[2]	16 March	near mouth of Bat Cave Draw	1,160	18.5 (33.5)
female[2]	16 March	near mouth of Bat Cave Draw	1,140	18.5 (33.5)
female[3]	9 May	below Bat Cave Draw	1,170	26.0 (48.8)
female[2]	13 March	near mouth of Slaughter Canyon	1,370	20.0 (36.4)
male[2]	13 March	near mouth of Slaughter Canyon	1,360	20.0 (36.4)
female[2]	13 March	near mouth of Slaughter Canyon	1,350	23.0 (42.5)
male[4]	12 March	near mouth of Slaughter Canyon	1,330	20.0 (36.4)
male[5]	12 & 13 March	near mouth of Slaughter Canyon	1,305	20.0 (36.4)
male[1]	15 March	near mouth of Yucca Canyon	1,410	25.0 (46.6)
male[1]	12 April	near mouth of Lefthook Canyon	1,480	27.0 (51.0)
male[1]	12 April	near mouth of Lefthook Canyon	1,500	28.0 (53.2)

[1]captured first night, traps set for one night.
[2]captured second night only, traps set for two nights.
[3]captured third night only, traps set for three nights.
[4]captured first night only, traps set for two nights.
[5]captured first and second nights, traps set for two nights.

captured in Sheep Draw on steeper slopes (18.5 and 22.5° or 33.5 and 41.4%) 0.6–1.2 km away from the gradual slopes; two mice were captured on the same night that traps were set on the gradual slopes, and two others were captured the previous night (total trap nights in Sheep Draw = 120).

Escarpment slopes in the Guadalupe Mountains continue to be gradual from Sheep Draw to the northern end of the eastern escarpment at the level of Little McKittrick Draw (Figs. 2 and 6). Thus, we did not continue our search for *C. nelsoni* farther north along the escarpment. Furthermore, when Geluso (2004) searched for new distributional records of the Lacey's White-ankled Deermouse (*Peromyscus laceianus*; formerly, *P. pectoralis*; see Bradley et al. 2015) in northern parts of the Guadalupe Mountains and beyond, he captured many *P. laceianus* but no *C. nelsoni*.

Because those saxicolous species occur sympatrically in the Guadalupe Mountains (see subsection—*Other rodents inhabiting escarpment*) and because Geluso's traplines included rocky slopes, *C. nelsoni* could have been captured if it was present.

Although further surveys might reveal *C. nelsoni* north of the Guadalupe Mountains, average annual temperatures might ultimately limit its northern range in New Mexico. For example, Gennaro (1968) studied the distribution of four species of rodents that reach their northern geographic limits in New Mexico. He concluded that Rock Pocket Mice (*Chaetodipus intermedius*) and Cactus Deermice (*Peromyscus eremicus*) were absent where suitable habitats were available only in areas north of certain isotherms. Perhaps *C. nelsoni* might not occur farther north than present data indicate because average temperatures are too cold.

Failure to capture *C. nelsoni* south of Lefthook Canyon in New Mexico is an enigma (Fig. 6). At our southernmost sites, traps were set multiple nights (total trap nights = 680), and except for one slope with an incline of 30° (57.7%) and a southwest exposure in the mouth of Franks Canyon, other slopes were similar in inclines (21, 22.5, 23, and 26°) and exposure (faced south and southeast) to those inhabited by *C. nelsoni* farther north. Slopes also were similar in amount of rock and types of vegetation. In terms of elevation, 25–30% of our trapsites were set below the highest elevation where *C. nelsoni* was captured near the mouth of Lefthook Canyon at 1,500 m. Farther south in Texas, Genoways et al. (1979) also reported no capture of *C. nelsoni* in the Guadalupe Mountains and surrounding lowlands, after examining >1,200 rodents from that area. However, few, if any, traps were set along the face of the eastern escarpment. If surveys were to be conducted along the eastern escarpment in Texas, all trapsites would be at least 1,560 m at the base of the escarpment at the Texas-New Mexico border, and they would be as high as 2,460 m at the upper edge of the eastern escarpment near the southern end of the Guadalupe Mountains.

In New Mexico, as we drove southwest from Rattlesnake Springs to the mouth of Franks Canyon along the relatively flat land below the escarpment (Fig. 2), air temperatures dropped several degrees as we gradually rose in elevation. The same phenomenon likely occurs with increases in elevation on slopes above the plains. Could elevation and concurrent effects on temperature be a limiting factor for *C. nelsoni* at higher elevations in the Guadalupe Mountains? In the Big Bend region of southern Texas, *C. nelsoni* has been reported as high as 1,695 m in elevation (Baccus 1971). However, those elevations are at lower latitudes where average temperatures likely are warmer compared to sites with identical elevations at higher latitudes. Nevertheless, additional surveys are warranted along the eastern escarpment in Texas and south of Lefthook Canyon in New Mexico because of limited past trapping efforts on those stretches of the escarpment.

Seasonal and nightly activity.—In the northern part of its range, Nelson's Pocket Mouse is active throughout the year. Individuals from the Guadalupe Mountains have been captured in January ($n = 1$), February (1), March (11), April (4), May (4), June (4), July (5), August (2), and October (1; Appendix). Year-round activity also occurs in populations farther south with milder climates (Yancey 1997; Porter 2011). In the Guadalupe Mountains, Nelson's Pocket Mouse is active on nights with new and full moons. All our captures in 2013 ($n = 18$) were on nights of the new moon or within five days of the new moon. Other investigators captured *C. nelsoni* near full moons, including five individuals on 15 July 2003 (traps set 14 July, clear night, full moon on 13 July, D. J. Hafner, pers. comm.) and one each on 7 February 2001 (full moon 8 February), 8 March 2001 (full moon 9 March), and 29 April 1991 (full moon 28 April; Appendix).

In 2013, Nelson's Pocket Mice were captured on the first night (56%, 10 of 18), second night (39%, $n = 7$), and third night (6%, $n = 1$) of trapping (Table 1). Of 10 individuals captured the first night, only two had the opportunity to be recaptured, and one was discovered in the trapline the following morning (captures on 12 and 13 March, Table 1). In 1991, Geluso and Geluso (2004) captured two individuals of *C. nelsoni* on the first night and two only on the second night of trapping.

Reproduction.—Reproductive information for *C. nelsoni* in the Guadalupe Mountains is limited for both males and females. In March 2013, two of five males had scrotal testes, but in April, May, and June of that year, all testes were scrotal ($n = 8$); testicular lengths were 7, 8, and 9 mm in voucher males having scrotal

testes (Table 2). On 15 July 2003, an adult male with scrotal testes (8 mm) was captured with four subadults with non-scrotal testes (4–5 mm, Appendix). In 1991, males captured in April, May, and August had scrotal testes measuring 8.0, 8.5, and 8.0 mm in length, respectively (Geluso and Geluso 2004). In summary, males with scrotal testes were observed March–August in the Guadalupe Mountains. Those reproductive data are comparable with males inhabiting the Big Bend area of Texas. On the basis of a much larger sample ($n = 52$), Porter (2011) reported that testes reach maximum size May–June and that at least some individuals possess large testes in March, April, and July. Yancey (1997) reported enlarged testes in February (8 mm in length) and August (7 and 8 mm).

In 2013, a lactating female was captured in the Guadalupe Mountains on 9 May (Table 2). Other females ($n = 3$) with developed nipples were captured on 13 March, 16 March, and 7 June, but they were not lactating, and we were unable to determine whether they were pregnant (Table 2). On 13 March, a female was captured with undeveloped nipples. In 1991, a female captured in the Guadalupe Mountains on 4 August had six developed nipples that produced a clear liquid when the surrounding area was squeezed (Geluso and Geluso 2004). In the Trans-Pecos region of Texas, pregnant females have been reported March–August and lactating females on 22 June and 24 July (Manning et al. 1996; Yancey 1997; Yancey et al. 2006; Porter 2011).

Table 2. Sex, reproductive condition, and body weight for 18 Nelson's Pocket Mice (*Chaetodipus nelsoni*) captured in southeastern New Mexico in 2013. Mice are listed chronologically by date of capture. Number in parentheses indicates length of testes in mm.

Sex	Date of capture	Reproductive condition	Body weight (g)
male	12 & 13 March	non-scrotal	17.5
male	12 March	non-scrotal	17.0
male	13 March	non-scrotal	16.5
female	13 March	nonreproductive[1]	13.5
female	13 March	nonreproductive[1]	13.8
male	15 March	scrotal	19.0
female	16 March	nonreproductive[1]	14.5
male	16 March	scrotal	16.3
male	8 April	scrotal (9)	17.0
male	12 April	scrotal	16.0
male	12 April	scrotal	18.4
male	6 May	scrotal	17.0
male	6 May	scrotal (7)	14.0
female	9 May	lactating	14.8
female	7 June	nonreproductive[1]	16.0
male	7 June	scrotal (8)	15.5
male	8 June	scrotal	17.0
male	8 June	scrotal	15.5

[1]not lactating and unable to determine whether pregnant or not.

Other rodents inhabiting the eastern escarpment.—In 2013, 293 individuals of 10 species of rodents, including *C. nelsoni*, were captured along the eastern escarpment of the Guadalupe Mountains. Nelson's Pocket Mice were most often associated with *Peromyscus laceianus*, as every site occupied by *C. nelsoni* also was inhabited by *P. laceianus* (Table 3). White-toothed Woodrats (*Neotoma leucodon*) occurred in 44% of sites with *C. nelsoni*. Other rodents captured in traplines with *C. nelsoni* included the Cactus Deermouse (*Peromyscus eremicus*), Merriam's Kangaroo Rat (*Dipodomys merriami*), and the Chihuahuan Desert Pocket Mouse (*Chaetodipus eremicus*). One individual each of those three species was captured on steep (18.5–22.5° or 33.5–41.4%), rocky slopes in the mouth of Sheep Draw with *C. nelsoni*, *P. laceianus*, and *N. leucodon* (Table 3).

Other species of mammals captured on rocky slopes of the escarpment, but not at sites occupied by *C. nelsoni*, included the Texas Antelope Squirrel (*Ammospermophilus interpres*), Silky Pocket Mouse (*Perognathus flavus*), Hispid Pocket Mouse (*Chaetodipus hispidus*), and White-footed Deermouse (*Peromyscus leucopus*). One Texas Antelope Squirrel was captured near the mouth of Sheep Draw, and another was captured near the mouth of Franks Canyon (Fig. 6). Silky Pocket Mice were captured near the mouths of Sheep Draw (n = 3) and Chinaberry Draw (n = 1) and in the mouth of Threemile Draw (n = 10). One Hispid Pocket Mouse and two White-footed Deermice were captured in the mouth of Threemile Draw. Other individuals captured at sites not occupied by *C. nelsoni* included *P. laceianus* (n = 96), *N. leucodon* (n = 36), *P. eremicus* (n = 33), *D. merriami* (n = 1), and *C. eremicus* (n = 1; see X symbols in Fig. 6).

In contrast to our findings in the Guadalupe Mountains, Nelson's Pocket Mice inhabiting the Beach Mountains, Chinati Mountains, and Big Bend National Park in the Trans-Pecos region of Texas occur more often with *Peromyscus eremicus* than with *P. laceianus* (Stangl et al. 1993; Yancey et al. 2006; Jones et al. 2011; Porter 2011). Along the escarpment of the Guadalupe Mountains, many individuals of *P. eremicus* were captured only on gradual slopes (inclines 6–10.5° or 10.5–18.3%) near the mouth of Sheep Draw (9.2 individuals/100 trap nights, n = 22 individuals) and in the mouth of Threemile Draw (6.9/100, n = 11, Fig. 6). On those rocky slopes with desert scrub, we captured no individuals of *C. nelsoni* and a total of eight individuals of *P. laceianus*.

On the eastern escarpment of the Guadalupe Mountains, two Chihuahuan Desert Pocket Mice were captured on steep, rocky slopes of the eastern escarpment. One individual was captured in the mouth of Sheep Draw with *C. nelsoni*, and the other (MSB 270092) was captured in the mouth of Chinaberry Draw without *C. nelsoni* (Fig. 6). Although the Chihuahuan Desert Pocket Mouse usually occupies sandy or silty, rock-free soils in New Mexico and in the Trans-Pecos region of Texas (Findley et al. 1975; Schmidly 1977), it occasionally inhabits areas with gravelly, rocky, or boulder-strewn substrates, as demonstrated by our captures along the eastern escarpment in New Mexico in 2013 and by those of Yancey (1997) and Porter (2011) in the Big Bend area of Texas.

Where the western boundary of the range of *C. nelsoni* meets the eastern boundary of the range of the Rock Pocket Mouse (*C. intermedius*) in the Trans-Pecos region of Texas (see distribution maps in Schmidly 1977), there are several localities where these two saxicolous species occur together in Presidio County (Yancey 1997). Both species of pocket mice also are associated with the Guadalupe Mountains, where *C. nelsoni* is known from slopes of the eastern escarpment in New Mexico, and *C. intermedius* from foothills surrounding the southern tip of the mountain range in Texas (Davis and Robertson 1944; Genoways et al. 1979). The shortest distance between known records of those species in this region is about 20 km, from Lefthook Canyon in New Mexico (Fig. 6) to Bell Creek Canyon at the base of the eastern escarpment in Texas (1,615 m, Davis and Robertson 1944). Thus, the Guadalupe Mountains represent another potential region for sympatry.

Factors influencing the distribution of Nelson's Pocket Mouse.—Several factors appear to influence occurrence and distribution of *C. nelsoni* in the Guadalupe Mountains. At its northern geographic limit, habitat for *C. nelsoni* can be best defined by the following characteristics: (1) presence of exposed rock that covers much of the surface of the ground; (2) slopes with southerly exposure and inclines >18° (>32.5%); (3) sites with elevations ≤1,500 m; (4) presence of

Table 3. Capture rates for rodents at sites inhabited by Nelson's Pocket Mice (*Chaetodipus nelsoni*) in the Guadalupe Mountains of southeastern New Mexico in 2013. Rates are given as the number of individuals captured per 100 trap nights. Numbers in parentheses indicate total number of individuals captured; those totals include one recapture of a *C. nelsoni* and likely some recaptures of other species at sites where traps were set more than one night. Localities are listed from north to south (Fig. 6).

Locality	*Chaetodipus nelsoni*	*Peromyscus laceianus*	*Neotoma leucodon*	Number of trap nights
in mouth of Sheep Draw[1]	3.3 (4)	6.7 (8)	6.7 (8)	120[3]
in mouth of Dark Canyon	2.5 (2)	1.3 (1)	---	80[4]
near mouth of Chinaberry Draw	2.5 (1)	12.5 (5)	2.5 (1)	40[4]
near mouth of Bat Cave Draw	2.5 (2)	11.3 (9)	---	80[5]
below Bat Cave Draw	0.8 (1)	8.3 (10)	---	120[6]
near mouth of Slaughter Canyon	3.8 (6)[2]	13.8 (22)	---	160[7]
near mouth of Yucca Canyon	2.5 (1)	20.0 (8)	2.5 (1)	40[4]
near mouth of Lefthook Canyon	1.3 (1)	11.3 (9)	1.3 (1)	80[4]
near mouth of Lefthook Canyon	2.5 (1)	5.0 (2)	---	40[4]
Total number captured	(19)[2]	(74)	(11)	

[1]also captured one individual each of *Peromyscus eremicus*, *Dipodomys merriami*, and *Chaetodipus eremicus* (capture rate for each = 0.8 individuals per 100 trap nights).
[2]includes one recapture.
[3]forty traps set for one night and another 40 traps set for two nights.
[4]trapped one night.
[5]forty traps set for two nights.
[6]forty traps set for three nights.
[7]eighty traps set for two nights.

desert plants such as prickly pears, catclaws, spiny cactuses, Ocotillo, Lechuguilla, Smooth Sotol, Skeletonleaf Goldeneye, and cloakferns; and (5) grasses that cover ≤30% of the ground. In most respects, such characteristics of habitat in the Guadalupe Mountains are similar to those described for other populations of *C. nelsoni* occurring farther south in the Trans-Pecos region of Texas. For example, in the Beach Mountains, Nelson's Pocket Mice were captured only at one site at an elevation ca. 1,310 m on a south-facing slope dominated by Lechuguilla; the slope was rocky and steep (>20° or >36.4%, F. B. Stangl, pers. comm.). In Big Bend National Park, *C. nelsoni* was most abundant on rocky slopes containing cobbles and boulders and with inclines of 16.7–21.8° (30–40%); it attained greatest densities where ground cover included prickly pears, Lechuguilla, Smooth Sotol, and Chino Grass (*Bouteloua ramosa*); and it was captured at elevations of 580–1,675 m (Porter 2011). In addition, Baccus (1971) reported that *C. nelsoni* was most abundant on steep, rocky slopes between 1,220 and 1,675 m in the park, and Dixon (1958) reported that *C. nelsoni* was virtually restricted to rocky slopes containing prickly pears and Lechuguilla at 670 m, after trapping both rocky slopes and gravelly flats in Black Gap Wildlife Management Area, adjacent to the park.

Although exposed rock and steepness of slope both appear to be important habitat characteristics for *C. nelsoni* in general, Porter (2011, p. 58) stated that steepness of slope might not be the driving factor for inhabitance by *C. nelsoni* in Big Bend National Park, but rather, large rocks were associated most often with steep slopes in the park. In contrast, steepness and exposure of slopes might be important factors for *C. nelsoni* at the northern part of its geographic distribution. In the

Guadalupe Mountains, Geluso and Geluso (2004) did not capture *C. nelsoni* in many habitats containing abundant amounts of exposed rock and desert plants; it only was captured in rocky areas where the terrain was steep with southerly exposures along the escarpment. Absence from other rocky habitats might be related to ambient temperatures. At this northern latitude, temperature might become a factor, and only slopes receiving enough solar radiation are warm enough for inhabitance by *C. nelsoni*. If accurate, then steepness, exposure, and elevation of slopes, as well as rocks and desert plants, appear to be important habitat characteristics for *C. nelsoni* in the Guadalupe Mountains. Moreover, with warmer conditions at more southerly latitudes, steepness and exposure of slope might not be as critical, resulting in *C. nelsoni* "occasionally" occupying gradual slopes in Big Bend National Park (e.g., 1.2–5.7° or 2–10%, Porter 2011, pp. 42 and 43). In Big Bend Ranch State Park, Yancey (1997) also captured *C. nelsoni* in habitats with relatively flat terrain and stated that nearly all sites occupied by *C. nelsoni* were associated with rocks.

With additional surveys in other areas of the Guadalupe Mountains in New Mexico and Texas, *C. nelsoni* might be discovered at other locations in this mountain range. Trapping slopes of western escarpments might prove to be most productive, especially on southwest-facing and south-facing slopes. Other possibilities for success include trapping along rocky arroyos and boulder-strewn draws near mouths of canyons and other drainages on the west side of the mountains. Additional trapping on interior canyonsides with southerly exposures and desert vegetation on both eastern and western sides of the mountain range also might be fruitful.

Numerous, semi-isolated populations of *C. nelsoni* exist in the Trans-Pecos region of Texas (Blair 1950; Best 1994), and the population of *C. nelsoni* inhabiting the Guadalupe Mountains likely is geographically isolated to some extent from more southerly populations in Texas. *Chaetodipus nelsoni* shows a pronounced preference for rocky slopes in mountainous areas, and the wide expanses of relatively flat land that surround the mountains are at least partial barriers to dispersal (Blair 1950). Thus far, the closest known population of *C. nelsoni* in the Guadalupe Mountains is ca. 112 km south-southwest in the Beach Mountains, Culberson County, Texas (Stangl et al. 1993). Trapping any type of rocky habitat between those mountain ranges would be informative, especially slopes of Sierra Diablo and Delaware mountains.

Population status.—On the basis of 33 records from the Guadalupe Mountains (Appendix), Nelson's Pocket Mice have inhabited this mountain range for at least 60 years (1952–2013) and at one site in New Mexico, for at least 40 years (1973–2013). Eighteen individuals of *C. nelsoni* were captured in 2013, including adult males and females, one of which was lactating. The lactating female (locality 7, Fig. 6) was captured 0.96 km from where the first record of *C. nelsoni* was obtained in the mountain range in 1952. As of 2013, the population of *C. nelsoni* in the Guadalupe Mountains appeared stable. Nevertheless, due to its limited distribution and specific habitat requirements, we recommend that Nelson's Pocket Mouse be considered in future conservation strategies developed by the New Mexico Department of Game and Fish.

ACKNOWLEDGMENTS

We are grateful to Gavin J. Emmons and David J. Hafner for providing us with information on their captures of Nelson's Pocket Mice in Carlsbad Caverns National Park and to Frederick B. Stangl, Jr., for additional information on his captures in the Beach Mountains. We thank Renée West (Supervisory Biologist, Carlsbad Caverns National Park) for a wide range of technical support at the park, including assistance in obtaining collecting permits to conduct research on park property. We also thank Stanley Allison of the National Park Service for his detailed map that enabled us to reach our southern destinations; Angie Fox (Scientific Illustrator, University of Nebraska State Museum) for preparing Figures 2 and 6; Jonathan L. Dunnum (Museum of Southwestern Biology) and Patricia Gegick (New Mexico Museum of Natural History & Science) for assistance with museum matters; and Chuck L. Hayes (Share with Wildlife Coordinator, New Mexico

Department of Game and Fish) and Michael C. Mohatt (Sponsored Programs and Research, University of Nebraska at Omaha) for their time and effort to insure that funding phases of this project ran smoothly. We also thank Jennifer K. Frey for her constructive advice on an earlier version of our manuscript. This study was funded by the Share with Wildlife Program, New Mexico Department of Game and Fish (Professional Services Contract #14 516 0000 00012) and United States Fish and Wildlife Service (CFDA #15.634, State Wildlife Grant T-32-P-3, Project 12).

LITERATURE CITED

Baccus, J. T. 1971. The influence of a return of native grasslands upon the ecology and distribution of small rodents in Big Bend National Park. Ph.D. dissertation, University of North Texas, Denton, 114 pp.

Bailey, V. 1905. Biological survey of Texas. North American Fauna 25:1–222.

Bailey, V. 1928. Animal life of the Carlsbad Cavern. Monograph of the American Society of Mammalogists 3:1–195.

Best, T. L. 1994. Chaetodipus nelsoni. Mammalian Species 484:1–6.

Blair, W. F. 1950. The biotic provinces of Texas. The Texas Journal of Science 2:93–117.

Bradley, R. D., D. J. Schmidly, B. R. Amman, R. N. Platt II, K. M. Neumann, H. M. Huynh, R. Muñiz-Martínez, C. López-González, and N. Ordóñez-Garza. 2015. Molecular and morphologic data reveal multiple species in *Peromyscus pectoralis*. Journal of Mammalogy 96:446–459.

Davis, W. B. 1940. Mammals of the Guadalupe Mountains of western Texas. Occasional Papers of the Museum of Zoology, Louisiana State University 7:69–84.

Davis, W. B., and J. L. Robertson, Jr. 1944. The mammals of Culberson County, Texas. Journal of Mammalogy 25:254–273.

Dixon, K. L. 1958. Spatial organization in a population of Nelson pocket mouse. The Southwestern Naturalist 3:107–113.

Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, 360 pp.

Frey, J. K. 2009. Distinguishing range expansions from previously undocumented populations using background data from museum records. Diversity and Distributions 15:183–187.

Geluso, K. 2004. Distribution of the white-ankled mouse (*Peromyscus pectoralis*) in New Mexico. The Southwestern Naturalist 49:283–288.

Geluso, K. N., and K. Geluso. 2004. Mammals of Carlsbad Caverns National Park, New Mexico. Bulletin of the University of Nebraska State Museum 17:1–180.

Gennaro, A. L. 1968. Northern geographic limits of four desert rodents of the genera *Peromyscus*, *Perognathus*, *Dipodomys*, and *Onychomys* in the Rio Grande Valley. The American Midland Naturalist 80:477–493.

Genoways, H. H., R. J. Baker, and J. E. Cornely. 1979. Mammals of the Guadalupe Mountains National Park, Texas. Pp. 271-332 in Biological investigations in the Guadalupe Mountains National Park, Texas (H. H. Genoways and R. J. Baker, eds.). Proceedings and Transactions Series, National Park Service 4:1–442.

Hafner, M. S., W. L. Gannon, J. Salazar-Bravo, and S. T. Alvarez-Castañeda. 1997. Mammal collections in the western hemisphere: A survey and directory of existing collections. American Society of Mammalogists, Allen Press, Lawrence, Kansas, 93 pp.

Hall, E. R. 1981. The mammals of North America. John Wiley and Sons, New York, 1:xv + 1–600 + 90 pp.

Hill, C. A. 1987. Geology of Carlsbad Cavern and other caves in the Guadalupe Mountains, New Mexico and Texas. New Mexico Bureau of Mines and Mineral Resources Bulletin 117:1–150.

Jagnow, D. H., and R. R. Jagnow. 1992. Stories from stones: The geology of the Guadalupe Mountains. Carlsbad Caverns-Guadalupe Mountains Association, Carlsbad, New Mexico, 40 pp.

Jones, C., M. W. Lockwood, T. R. Mollhagen, F. D. Yancey, II, and M. A. Bogan. 2011. Mammals of the Chinati Mountains State Natural Area, Texas. Occasional Papers, Museum of Texas Tech University 300:1–29.

Manning, R. W., F. D. Yancey, II, and C. Jones. 1996. Nongeographic variation and natural history of two sympatric species of pocket mice, *Chaetodipus nelsoni* and *Chaetodipus eremicus*, from Brewster

County, Texas. Pp. 191–195 in Contributions in mammalogy: A memorial volume honoring Dr. J. Knox Jones, Jr. (H. H. Genoways and R. J. Baker, eds.). Museum of Texas Tech University, Lubbock, 315 pp.

Porter, R. D. 2011. Movements, populations, and habitat preferences of three species of pocket mice (Perognathinae) in the Big Bend region of Texas. Special Publications, Museum of Texas Tech University 58:1–107.

Powell, A. M. 1988. Trees and shrubs of Trans-Pecos Texas, including Big Bend and Guadalupe Mountains national parks. Big Bend Natural History Association, Big Bend National Park, Texas, 536 pp.

Powell, A. M. 1994. Grasses of the Trans-Pecos and adjacent areas. University of Texas Press, Austin, 377 pp.

Rice-Snow, S., and J. Goodbar. 2012. Terrain factors in Capitan aquifer recharge, northeastern Guadalupe escarpment, New Mexico. New Mexico Geology 34:15–22.

Schmidly, D. J. 1977. The mammals of Trans-Pecos Texas, including Big Bend National Park and Guadalupe Mountains National Park. Texas A&M University Press, College Station, 225 pp.

Stangl, F. B., Jr., W. W. Dalquest, and S. Kuhn. 1993. Mammals from the Beach Mountains of Culberson County, Trans-Pecos, Texas. The Texas Journal of Science 45:87–96.

Webb, O. L. 1954. *Perognathus nelsoni canescens* in New Mexico. Journal of Mammalogy 35:453.

Yancey, F. D., II. 1997. The mammals of Big Bend Ranch State Park, Texas. Special Publications, Museum of Texas Tech University 39:1–210.

Yancey, F. D., II, R. W. Manning, and C. Jones. 2006. Mammals of the Harte Ranch area of Big Bend National Park, Brewster County, Texas. Occasional Papers, Museum of Texas Tech University 253:1–15.

Addresses of authors:

KENNETH N. GELUSO

Department of Biology
University of Nebraska at Omaha
Omaha, NE 68182
kgeluso@unomaha.edu

KEITH GELUSO

Department of Biology
University of Nebraska at Kearney
Kearney, NE 68849
gelusok1@unk.edu

APPENDIX

Localities of occurrence for 33 Nelson's Pocket Mice (*Chaetodipus nelsoni*) captured in the Guadalupe Mountains, Eddy County, New Mexico, from 1952 to 2013. Numbers in parentheses before each locality correspond to numbered circles in Figure 6. Localities in close proximity to each other are listed together and are represented by the same number. Localities near Slaughter, Yucca, and Lefthook canyons and those associated with Bat Cave Draw are in Carlsbad Caverns National Park. In the park, New Cave is presently called Slaughter Canyon Cave. Sex of individuals and dates of capture are given, as well as specimen numbers and institutional abbreviations, if kept as a voucher specimen. In addition, elevations (elev.) of capture sites are given for individuals collected in 2001 and 2003, reproductive information is given for those collected in 2003, and body weights are given for those collected in 1953, 1991, 2001, and 2003. Institutional abbreviations are as follows: Museum of Southwestern Biology, University of New Mexico (MSB); Carlsbad Caverns National Park (CACA); New Mexico Museum of Natural History (NMMNH); and University of Kansas Museum of Natural History (KU).

(1) in mouth of Sheep Draw, 17.3 km N, 2.8 km E Whites City, 32°19.831'N, 104°20.814'W, NAD 83; male captured 7 June 2013, MSB 270094.

(1) in mouth of Sheep Draw, 32°19.816'N, 104°20.858'W, NAD 83; male captured and released 8 June 2013.

(1) in mouth of Sheep Draw, 32°19.780'N, 104°20.765'W, NAD 83; female captured and released 7 June 2013.

(1) in mouth of Sheep Draw, 32°19.771'N, 104°20.836'W, NAD 83; male captured and released 8 June 2013.

(2) in mouth of Dark Canyon, 12.9 km N, 2.7 km E Whites City, 32°17.507'N, 104°20.853'W, NAD 83; male captured 6 May 2013, MSB 270097.

(2) in mouth of Dark Canyon, 32°17.495'N, 104°20.969'W, NAD 83; male captured and released 6 May 2013.

(3) near mouth of Chinaberry Draw, 1.1 km N, 1.4 km E Whites City, 32°11.144'N, 104°21.723'W, NAD 83; male captured 8 April 2013, MSB 270091.

(4) Bat Cave Draw, 1.61 km E of large natural opening to Carlsbad Cavern; male captured 8 October 1952, CACA 1458.

(5) Carlsbad Caverns National Park, 6.44 km W Whites City; male captured 26 January 1953, body weight 18.0 g, KU 52208.

(6) near mouth of Bat Cave Draw, 32°10.572'N, 104°23.226'W, NAD 83; male captured and released 16 March 2013.

(6) near mouth of Bat Cave Draw, 32°10.542'N, 104°23.228'W, NAD 83; female captured and released 16 March 2013.

(7) below Bat Cave Draw, 32°10.246'N, 104°25.414'W, NAD 83; female captured and released 9 May 2013.

(8) near mouth of Slaughter Canyon, 7.64 km S, 17.70 km W Whites City; female captured 7 March 1973, MSB 184756.

(8) near mouth of Slaughter Canyon, 0.39 km S, 0.37 km E New Cave; male captured 29 April 1991, body weight 15.0 g, MSB 64007.

APPENDIX (CONT.)

(8) near mouth of Slaughter Canyon, 0.39 km S, 0.37 km E New Cave; male captured 20 May 1991, body weight 16.5 g, MSB 64080.

(8) near mouth of Slaughter Canyon, 0.51 km S, 0.31 km E New Cave; female captured 4 August 1991, body weight 16.5 g, MSB 65064.

(8) near mouth of Slaughter Canyon, 0.51 km S, 0.31 km E New Cave; male captured 5 August 1991, body weight 16.5 g, MSB 65065.

(8) near mouth of Slaughter Canyon, 0.39 km S, 0.48 km E New Cave, elev. 1,310 m; male captured and released 7 February 2001, body weight 15.0 g

(8) near mouth of Slaughter Canyon, 0.42 km S, 0.32 km E New Cave, elev. 1,345 m; male captured and released 8 March 2001, body weight 15.0 g.

(8) near mouth of Slaughter Canyon, 8.85 km W Rattlesnake Spring, 32°06'27"N, 104°33'56"W, NAD 27, elev. 1,300 m; male captured 15 July 2003, body weight 15 g, scrotal testes 8 mm in length, NMMNH 4447.

(8) near mouth of Slaughter Canyon, 8.85 km W Rattlesnake Spring, 32°06'27"N, 104°33'56"W, NAD 27, elev. 1,300 m; male captured 15 July 2003, body weight 14 g, testes 5 mm in length, NMMNH 4448.

(8) near mouth of Slaughter Canyon, 8.85 km W Rattlesnake Spring, 32°06'27"N, 104°33'56"W, NAD 27, elev. 1,300 m; male captured 15 July 2003, body weight 13 g, testes 4 mm in length, NMMNH 4449.

(8) near mouth of Slaughter Canyon, 8.85 km W Rattlesnake Spring, 32°06'27"N, 104°33'56"W, NAD 27, elev. 1,300 m; male captured 15 July 2003, body weight 15 g, testes 4 mm in length, NMMNH 4450.

(8) near mouth of Slaughter Canyon, 32°06.537'N, 104°33.933'W, NAD 83; female captured and released 13 March 2013.

(8) near mouth of Slaughter Canyon, 32°06.524'N, 104°33.928'W, NAD 83; male captured and released 13 March 2013.

(8) near mouth of Slaughter Canyon, 32°06.493'N, 104°33.975'W, NAD 83; female captured and released 13 March 2013.

(8) near mouth of Slaughter Canyon, 32°06.483'N, 104°33.919'W, NAD 83; male captured and released 12 March 2013.

(8) near mouth of Slaughter Canyon, 32°06.446'N, 104°33.904'W, NAD 83; male captured and released 12 and 13 March 2013.

(9) near mouth of Yucca Canyon, 1.42 km S, 1.13 km W New Cave, elev. 1,370 m; male captured and released 20 March 2001, body weight 14.5 g.

(9) near mouth of Yucca Canyon, 1.61 km S, 10.46 km W Rattlesnake Spring, 32°05'56"N, 104°35'08"W, NAD 27, elev. 1,425 m; male captured 15 July 2003, body weight 12 g, testes 4 mm in length, NMMNH 4451.

APPENDIX (CONT.)

(10) near mouth of Yucca Canyon, 32°05.789'N, 104°35.332'W, NAD 83; male captured and released 15 March 2013.

(11) near mouth of Lefthook Canyon, 32°04.838'N, 104°37.830'W, NAD 83; male captured and released 12 April 2013.

(12) near mouth of Lefthook Canyon, 32°04.791'N, 104°38.042'W, NAD 83; male captured and released 12 April 2013.

PUBLICATIONS OF THE MUSEUM OF TEXAS TECH UNIVERSITY

This publication is available free of charge in PDF format from the website of the Natural Science Research Laboratory, Museum of Texas Tech University (nsrl.ttu.edu). The authors and the Museum of Texas Tech University hereby grant permission to interested parties to download or print this publication for personal or educational (not for profit) use. Re-publication of any part of this paper in other works is not permitted without prior written permission of the Museum of Texas Tech University.

Institutional subscriptions to Occasional Papers are available through the Museum of Texas Tech University, attn: NSRL Publications Secretary, Box 43191, Lubbock, TX 79409-3191. Individuals may also purchase separate numbers of the Occasional Papers directly from the Museum of Texas Tech University.

Series Editor: Robert D. Bradley
Production Editor: Lisa Bradley

ISSN 0149-175X

Museum of Texas Tech University, Lubbock, TX 79409-3191